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ADDRESS OF THE PRESIDENT OF THE ROYAL SOCIETY[1]

By Sir WILLIAM BRAGG, O.M.

THE tragic happenings of these times have necessarily had their effect on the activities of the society. On the outbreak of war, the offices were moved—as had been decided sometime beforehand—to Trinity College, Cambridge, and I take this opportunity of expressing the gratitude of the society for the hospitality which we have found there. We could not have wished, if we were to be in exile, any greater happiness than to be housed in the college of Isaac Newton and many another of our fellows, past and present. Many of our irreplaceable possessions were removed to places of safety.

The meetings for the reading of papers have been suspended temporarily, but their early resumption is possible, and will certainly take place if circumstances allow. The publication of papers has not been interrupted, though it has seemed well to place some limits on their length. Most of the other activities of the society, including the administration of funds for research, are proceeding as usual.

The council's report deals with the business of the society during the past year, and the second volume of "Notes and Records" tells of many other matters of interest. I am thereby relieved of the necessity of referring in this address to several subjects already considered. I propose to say a few words on the general position of the Royal Society at this special time. But first I would speak of the debt which the society owes to its retiring treasurer, Sir Henry Lyons. We owe to him the complete and valuable reform of our finances carried out during years when the monetary transactions and responsibilities of the society have been growing at a great rate; he has made welcome

[1] Anniversary meeting, November 30, 1939.

improvements in the conduct of our business; our house and rooms are much the better for his care: nor can we forget the successful introduction and maintenance of "Notes and Records" to which I have already referred. In very many other ways we are his debtors. The society parts reluctantly with the treasurer, who has so splendidly filled his office for the past ten years. Perhaps his effectiveness does not disappear with the tenure of his office, for as long as he is with us his critical yet friendly eye will make it impossible for any one to be careless in the society's business.

A very large number of our fellows are serving in different capacities for the prosecution of the war. Twenty-five years ago the war, which to so many of us seems to have been resumed after a very short interval, taught the world the importance of science and its application, and that not merely in the war itself but in many subsidiary activities and indeed by example and by inference in all human undertakings. The lesson has not been forgotten in the years that have intervened, and the present outbreak finds all our defence services far ahead of 1914 in the employment of science and scientific men. For this we must be profoundly thankful; for it is clear now that any nation which fell behind in this respect by even a few years of study and application would quickly be overwhelmed. It is early to form a complete estimate of the effectiveness in the present war of the attention that has been given to science in the last twenty years, but there is no little promise in what we are permitted to know of what is going on. There is evidence that the application of science in all sections of war-activity, land, sea and air, are proving their value and more than justify all that has been spent upon them.

There is indeed a wide-spread recognition of the general effectiveness of science. The ways of using science and scientific men are being slowly discovered. But the process is slow. It would, I think, be hastened, if certain fundamental truths were generally known and recognized. I venture to state them in the form of a few propositions:

(1) Science, that is to say, the knowledge of nature, is of fundamental importance to the successful prosecution of any enterprise. For example, a nation is obliged to make all possible use of science in preparation for war, whether aggressive or defensive: and, again by way of example, in the maintenance of public health and social welfare. Of course, science is not alone in being a necessity in either case.

(2) Science is of general application. There are not one science of chemistry, another of electricity, another of medicine and so on: there are not even distinct sciences of peace and war. There is only one natural world, and there is only one knowledge of it.

Experience shows that an advance in knowledge or technique or skill in any direction may be based on some item of knowledge acquired in a far distant field of research. For that reason, it is necessary to resist strongly a natural tendency for those who study science or apply it, to separate into groups without mutual communication.

(3) Fruitful inventions are alway due to a combination of knowledge and of experience on the spot. Unless the man with knowledge is present at the place and the time when some experience reveals the problem to be solved he misses the fertilizing suggestion. Neither can the mastering idea suggest itself to the man who has the experience only but no knowledge by which to read the lesson that the experience teaches. The man with knowledge may be a temporary or special introduction, or, which is much better, he may be the man who meets with the experience.

(4) There are difficulties peculiar to the application of science to war purposes. While the war proceeds scientists as a body are anxious to put all their knowledge at the service of their country: but when the time comes they are anxious to get away to their work on pure science or the applications of science to the problems of peace. Government may preserve and most fortunately has preserved a nucleus of able scientific effort during the last 20 years of peace, so that a certain connection is maintained between these particular applications and the general body of science: but from the very nature of their respective occupations, and on account of a certain secrecy which one of the two bodies is forced to maintain, the connection is not always strong. It can easily happen that the solution of a particular difficulty in the war service may lie in some piece of knowledge far away from the immediate science of the enterprise and unknown to those who need it.

I believe that the four statements which I have just made and briefly amplified are true, and must be acknowledged to be true by all careful observers. That being the case, it is of the utmost importance to move in the direction in which they point. We must ourselves be interested in any attempt to do so. We must wish to see that the vast and growing body of natural knowledge is most effectively employed in the service of the nation.

The tremendous use of science in the present war compels us to think about the method of its use. Many suggestions have already been made: as, for example, that a ministry of science should be formed immediately. In my opinion there is no solution here. A ministry would be too formal and rigid at any rate for immediate needs; the most successful ways of using knowledge are personal and elastic. We must not attempt too much at once. We might be content if we could in some way bring science as a whole into close relation with government as a whole, if we could attach a central authority of science to the central au-

thority of the country. The immediate application of science in any department of the country's business should be made from within the department, not from without, and we have already a number of instances in which this principle is followed. The Department of Scientific and Industrial Research, which we are proud to think of as an original device of the society, correlates many branches of industry with science: it is entrusted with the administration of large funds, and has had great successes. Similarly, the Medical Research Council administers funds and encourages research in the interests of the health of the people, and again the Agricultural Research Council has its own field of action. Each department of the defence forces takes care of its own applications of science. This is satisfactory so far as it goes. The need is rather for means whereby the government, in its care for the whole sweep of the country's business, can rely on and make use of the whole range of scientific knowledge.

It would seem that our society itself is a body which is not used as it might be, though, as I have said already, a large number of our fellows are individually taking part in the application of natural knowledge. Within its ranks are to be found men with knowledge of every form of natural science. It would be well if by way of some small group of fellows, selected for the purpose, it were consulted without hesitation whenever the need arose, and if it were kept so well informed that it might foresee occasions and needs. If that could be achieved, a forward step would be made, which in due time would be followed by others. It would be a very proper step to take, being a continuation and extension of a process which already exists. To use a modern term, science is irresistibly making its way into general use by a "peaceful penetration," which in the end is far more effective than a violent movement; all the more so because science is not out to fight present methods of rule and economy but rather to strengthen with new knowledge of facts and principles. We have often proved in this country the practical value of making use of existing institutions rather than founding new ones, when the old are full of vigor and can carry new grafts without strain. That is why the Royal Society, as a body of high consultative value, is ideally fitted to form the next link between knowledge and practice.

There are two subsidiary consequences of the present position of science which need to be remembered. We have not long passed the stage, if indeed we have quite gone past it, when our knowledge of nature is used as a reference library is used. The knowledge is there, on the shelves, to be taken down when any one wants information on a particular point and happens to remember where possibly it may be obtained.

Any one who wants to use a library effectively must already have some knowledge of the same nature as that which he hopes to find there. If not, he does not know where or how to look; nor can he grasp fully what he finds, even if he happens to hit upon the right book. For a parallel reason, it is most important that a general knowledge of science should be diffused among the people, and especially among those to whom it falls to guide and govern.

A second consequence is that the supply of men capable of the study and interpretation of the natural world must be made continuous. An instance, special to the moment, is the present policy of reserving able men in their final year at universities and technical institutions so that they are not absorbed too early into the fighting services nor into inappropriate branches thereof. This is necessary; but it is not all that is necessary. National interests demand that the water shall not be diverted higher up the stream.

And it may be well to add here that the care for those who can in due course be expected to supply the knowledge of nature and to assist in its use is not the nation's only care. It would be absurd to overlook other knowledge: I am but limiting myself to matters with which the society is especially concerned.

Let me now turn to a question of pure science. When the new methods of x-ray analysis were first introduced a quarter of a century ago there was naturally no clear realization of the extent and character of the fields of research in which they would eventually be employed. Certain applications were found for them at once, but the years have brought wide and unexpected developments. Some of these are gathering themselves together, and, in conjunction with other methods of physics and chemistry, begin to form what might well be called a new branch of science.

In the early phase of the x-ray crystal studies the object of interest was the perfect crystal; in the later phase attention is directed towards the departures from perfection, which turn out to be of the greatest interest and importance.

It will be remembered that the method of analysis of the structure of matter by means of x-rays was based upon a suggestion made by Dr. Laue. If the atoms in a crystal were in regular array, the passage of ether waves through the crystal should be accompanied by diffraction effect provided that the lengths of the waves were of the same order of magnitude as the spacings of the atoms. In the case of the ether waves emitted by an x-ray bulb—if indeed the x-rays were ether waves, of which there was some doubt at the time—there were reasons to suppose that the wavelengths were of the magnitude required. The experiment was made, and was successful.

The diffraction effects provided means whereby the crystalline arrangements could be calculated. The researches of the first few years of x-ray analysis were

therefore concerned with the character of the crystalline arrangement in a number of the simpler cases. As confidence grew and skill increased more difficult structures were attacked, and indeed it has been very surprising to find what complicated structures can be unravelled. One helpful circumstance has been the existence of families of substances, since the progressive differences in the members of a family gave rise to corresponding changes in the diffraction patterns. Thus, for example, the large family of silicates was examined and the connections between composition and diffraction effects, and again between the latter and structure, were observed and compared. Certain simplicities and informities then appeared and it became possible to put in order a mass of details which had not previously appeared to have any relation with each other.

It was not long before the results in the field of research became so numerous that books of no small size were required to contain them. In thousands of cases the dimensions of the unit cell of the crystal were determined, and at least the space-group or character of the arrangement of the atoms within the cell. In a number of these cases the exact relative positions of the atoms could be found, though this additional task has often been formidable. Work of this kind continues and rightly so, to be the occupation of many investigators. All such work belongs to the first phase to which I have referred.

The application of the x-ray methods has for some time been entering on a second phase. It now deals with a natural phenomenon differing entirely from that which was the first to be examined. The earlier work was concerned with the arrangement of the atoms in a perfect crystal, that is to say a body in which the mutual forces are balanced, and the arrangement is complete. Thermal movements may still be there, but the average dispositions of the atoms are settled, and are uniform throughout the body of the crystal.

It is doubtful whether there is such a thing as a perfect crystal large enough to be handled; perhaps the crystals of diamond and graphite are nearest to perfection. In almost all cases there are deviations from complete uniformity. A crystal that has every appearance of being perfect may consist of an assemblage of minute crystallites, more nearly perfect individually but lacking uniformity of orientation to a greater or less degree. Other bodies that do not appear to be crystalline at all may consist of crystallites oriented so irregularly that the bodies seem to be isotropic. The crystallites may vary in size as well as in relative orientation. Two or more crystal forms may be present in the same body, so mixed together that only the x-ray methods can make any attempt to disentangle them. Sometimes one greater lattice overrides in a more or less regular fashion a smaller lattice as a pattern of ploughed fields may override a pattern of furrows. Also a lattice may be distorted by strain. In a substance in the liquid state there may be associations and partial arrangements sufficient to show x-ray diffraction.

Moreover, arrangements and dimensions may vary with time, both in solids and liquids; some forms or extents of arrangement may even disappear, new forms may appear at the expense of the old. Perfection of crystalline arrangement is a goal which is never achieved. And in fact the processes of the world are based upon such deviations from perfection, and their continuous modification. If all arrangements of atoms were complete, there would be nothing left but stagnation and the peace of death.

It will be seen, therefore, that a new field of research of extraordinary interest is being opened up. It is in this field that the physicist and chemist and indeed scientists of every persuasion must look for explanations of many of the properties of their materials such as their relations to magnetism and electricity, thermal conductivity, tensile strength, various surface effects and so on: as also the time-changes in these properties, such as the creep to which the engineer has to give so much attention. Properties such as these have been called by Orowan and others the "sensitive" properties since they depend on the particular state of a body, which state in turn depends largely on the conditions of the new field of which I am speaking. The biologist finds interest in it, because the life processes seem to involve the relations between large aggregates, molecules or assemblages of molecules, with one another or with media in which they are imbedded. Somewhere in this field life and matter are first found in association.

It may seem unreasonable to expect help in the resolution of such complications from the x-ray diffraction effects. It is to be remembered, however, that the x-ray photographs are very rich in information. The gratings are three-dimensional and may be examined from a variety of aspects; each photograph or spectrometer record is a two-dimensional diagram of positions and intensities of diffracted spots. A light spectrum of the ordinary kind is uni-dimensional only. The photographs vary in definition, being less easy to read as they deal with more complicated cases; but the technique is rapidly improving.

The earliest of these phenomena of the larger field was the so-called mosaic effect. A crystal of rocksalt, for example, is a mass of small crystals, each of which approaches to regularity far more completely than the whole. The separate crystallites are not in perfect alignment with each other. Hence arose one of the perplexities of the early days. It was extraordinary to find that the less perfect crystal reflected the x-rays in greater intensity than the more perfect and that the

reflections from the face of a crystal, quartz, for example, might be increased if the surface was roughened. The puzzle is solved if we remember that, as Darwin and others pointed out, one crystallite may screen another. If the orientations of the two are exactly the same, and they are set at the proper angle for reflecting the incident x-rays the first crystallite will partly absorb the rays in producing its own reflection and the lower will not have its full opportunity. But if, as is usual, the crystal is moved through small angles about the above setting so as to give every crystallite its chance—provided that the x-rays can penetrate the crystal so far as to reach it—then the second will be in the right orientation for reflection when the first is not. The incident rays get through the first and are reflected by the second; the integration of all effects therefore gives a larger total when the crystallites are not parallel. This mosaic character is very common, even in crystals of the purest material. There are indications, as remarked by Goetz and others, that in some cases at least it is the state of greater equilibrium. Thus W. A. Wood shows that crystals of copper and other metals of extreme purity are reduced by cold working to crystallites in more or less complete disarray. The substances do not then return to their former state, though they can be taken some way toward it by moderate heating. To restore them to their original state it would be necessary to begin over again from the melt. A similar effect was shown by Ewald to occur in the case of rocksalt. It may also be significant that of the two forms of diamond examined by Robertson and Fox, that which is the more transparent to infra-red and ultra-violet and may therefore be taken to be in greater internal equilibrium is also the one in which there is some mosaic character.

If this form of disintegration of a larger crystal into crystallites is really due to the release of energy, it might be expected to proceed until the process was complete and the substance became amorphous. Wood shows that it does not proceed indefinitely and that the copper crystallites have an average linear dimension of about 700 A; for silver the figure is 800, for metal 1,200, and so on. The disintegration ceases at a certain point. The metals were of extreme purity. Unless it appears that the mere trace of impurity governs the effect, it must be supposed that the disposition to form aggregates of definite magnitude is present in the copper atoms themselves.

The presence of crystallites of a definite pattern, their dimensions, their preference for any particular orientation in relation to the body which contains them and their proportional amounts are all determined by the x-ray photographs. It is to be remembered that the diffraction spectra of a compound of different crystallites do not modify nor disturb each other's evidence. The data on which calculations are based are the forms and intensities of the spots and lines in the x-ray photography. The calculations are often difficult and lengthy because so many factors have to be taken into consideration; in fact there is plenty of evidence, and the most troublesome part of the business is its interpretation.

It will be readily understood that such measurements as these can be of great assistance in the study of metals. It is possible to examine in a new and most effective way the phase diagrams of the metallurgist, and the various effects of composition, temperature and time, and this not only for binary alloys but also for ternary and still more complicated mixtures. With these powers in hand, and with the remarkable accuracy of the modern x-ray spectrometer which can show minute changes of form due to temperature or an admixture of foreign atoms and can show also any variations in the extent of order and disorder in the atomic arrangements, it is not surprising that theoretical metallurgy has acquired a new life and that practical metallurgy begins to gain thereby.

Since the x-ray methods can do so much to discover the composition of molecules, even very large molecules such as the phthalocyanines (Robertson) or the sterols (Bernal, Crowfoot and others), and also to determine the arrangement of the molecules in crystalline aggregates and yet further to find any preferred orientations that there may be, the methods can be fitly used for the examination of fibrous materials. In cotton, silk, rubber and many other substances there are long chain molecules which are linked together into crystallites having preferred orientations along the length of the fiber. So also nerve, muscle, horn and such like contain proteins and keratins in fibrous forms. It is even possible, as Bernal has shown, to find some details of the composition, structure and arrangement of immense molecules such as those of a virus. Very interesting papers on these subjects have been communicated to our society, some of them during the present year.

It is to be observed that the extension of the x-ray methods to these larger scale problems is greatly facilitated by extrapolation from simpler observations. In the case of organic substances the modes of assemblage into characteristic combinations of atoms, such as the association of carbon atoms in the benzene ring, are governed by rules which are so closely followed in the simpler cases that they can be assumed to hold in the more complicated. These rules relate to the distance from atom to atom in various cases, and the mutual orientations of atoms. In this way very important suggestions have been made in respect to the construction of the more difficult assemblages.

It is to be remembered, of course, that there are other physical methods of observation which contribute to the understanding of the complex substances of

nature, which are all the more efficient now that the x-ray methods are able to make their characteristic contribution. First of all comes chemical science, the power of which is so obvious and well known that I need not do more than refer to it. Optical properties have been found to be extremely useful. So also the magnetic properties are found to be closely related to structure. Thus, for example, the disposition of a molecule containing benzene rings can often be predicted from diamagnetic measurements.

The sum total of these powers, some new, some old, all reinforcing each other in a common advance, is so great that, as I have already said, a new field of inquiry of first-rate importance has been well entered. That which the eye can see is one thing; that which the microscope reveals is another. Far beyond any vision is the individual atom and the atomic nucleus, of which so much has been discovered in recent years. But a vast range of magnitudes, lying approximately between 10 and 10,000 A has never been accessible to the direct attack which the ranges on either side of it have experienced. Within this range lie all the processes which are concerned in the building of living substances, animal and vegetable, and in the changes of growth and decay. In this range lie also elements that are the origin of the properties of our materials, alloys, glasses, fibrous substances of all kinds, and here take place transformations which change these properties, some of them rapid especially when urged by heat, some so slow that centuries must pass before they become visible or effective. The recent advance into this new field is only the preliminary to what is sure to follow. We have before us an inquiry of supreme interest.

OBITUARY

HAVEN METCALF

1875–1940

DR. HAVEN METCALF, principal pathologist in charge of the division of forest pathology, of the U. S. Bureau of Plant Industry, died on May 23, at Washington, after long suffering from an incurable disease. He was born on August 6, 1875, the son of George Shepard and Prudence (Grant) Metcalf of Winthrop, Maine. The family history is given extensively in E. S. Stackpole's "History of Winthrop." His earliest American ancestor, Michael Metcalf, son of Rector Leonard Metcalf, of Totterford, Norfolk County, England, came over on the ship *John and Dorothy* in 1637. The Metcalf clan was prominent and included physicians, ministers, public officials, professors, authors and editors and manufacturers. Joseph Addison Metcalf (1795–1845) founded a school now known as Gettysburg College (Pa.).

After finishing high school at Winthrop, Metcalf attended Colby from 1892 to 1894 and Brown, from which he received the degrees of B.S. in 1896 and A.M. in 1897. This was followed by further graduate work in botany, bacteriology and mycology at Brown in 1897–98, Harvard in 1899, Indiana in 1900 and with Professor Charles E. Bessey, at Nebraska, from which he received his Ph.D. in 1903. On June 28, 1899, he married a fellow student of Colby and Brown days, Flora May Holt, who died on April 26, 1935. Interspersed with his research, he was an instructor in botany at Brown from 1896 to 1899, instructor in bacteriology at Nebraska from 1901 to 1902, and assistant professor in botany and bacteriology at Clemson Agricultural College and state botanist, South Carolina, from 1902 to 1906. He also gave special lectures at Martha's Vineyard Summer Institute from 1896 to 1899 and the South Carolina State Summer School from 1903 to 1905. He joined the U. S. Bureau of Plant Industry as pathologist in 1906–07, and thereafter organized and administered the Division of Forest Pathology and its many branch offices.

Metcalf joined the Department of Agriculture when it was beginning to break away from purely systematic work and was attracting numbers of university graduates trained in the quantitative and mathematical methods of physics, chemistry and other sciences. Dr. Lyman J. Briggs, then biophysicist in plant industry, tells of the scientific club embodying such a group of enthusiastic young scientists, including Dr. E. R. Smith, in whose pathology laboratories Metcalf had worked a year. Smith reported at one meeting that a certain organism behaved differently on culture-media neutral to methyl orange than it did on the same media neutralized to phenolphthalein. He was puzzled. Briggs explained the matter in terms of the then current rudiments of present-day pH control. Metcalf had consistently believed in the advantages of the application of the physical sciences to biology. Shortly afterwards he visited the laboratories of the writer in the Johns Hopkins University, where colorimetric (indicators), electrometric and conductimetric pH methods were being evolved. Official cooperations on the development and application of such physical-chemical technique to forest pathology begun by them in 1914 continued to the present time, and were used increasingly in Metcalf's laboratories. He established close contacts with a number of leading universities and their scientists, many of whom later joined his staff, in order that forest pathology might be developed and applied with broad understanding.

His cooperative attitude, his stimulating combina-

tion of realism and idealism, of sound science with practical application, soon put him into a position of leadership in both state and federal activities. The development of forest pathology from the status of an academic study of tree fungi to its present standing as a science on which the arts of silviculture and forest utilization are increasingly dependent, has been largely due to his own efforts and those of the organization which he developed. The study of shade tree diseases, to which he gave special attention, contributed to the development of a sounder base for tree surgery and general tree care. The many-sided efforts against chestnut blight and the precedent-making campaign against white pine blister rust are two of the best-known outgrowths of his early work. Despite sharp opposition by influential mycologists, he early established the Asiatic origin of the blight; his educational work on the menace of introduced diseases gave impetus to the legislative and quarantine action that ended what he characterized as the period of "free trade in plant diseases."

It was inevitable that a man with his knowledge, vision and executive ability should have to share them in many public relations. He was president of the American Phytopathological Society in 1914, of the Botanical Society of Washington in 1920, and of the National Shade Tree Conference in 1925–26; associate editor of *Phytopathology* (1910–14); member of the American Botanical Society, Society of American Bacteriologists, Society of American Foresters, Washington Academy of Sciences, New England Botanical Club, Washington Biological Society, American Phytopathological Society (sustaining life member) and a fellow of the American Association for the Advancement of Science. He represented the United States in the International Conference on Phytopathology in Holland in 1923, and in Italy in 1908 arranged for importation of the colusa rice now grown extensively in California. He was a member of Phi Beta Kappa, Sigma Xi and Delta Upsilon fraternities and of the Cosmos Club and Washington Country Club.

Metcalf published eighty-four articles on diseases of forest trees, sugar-beet soft rot, bacterium teutlium, nematodes in plant decay, rice blast, chromosomes, immunity and scientific administration.

Because of his quiet, judicial temperament, Metcalf's advice was sought by friends and colleagues and given freely. Many and generous were his private contributions to charity and to the education of young people.

When advised by physicians that he must give up all personal scientific work and restrict his activities entirely to administration, he and Mrs. Metcalf found great enjoyment in books, music, art, genealogy and the theater. Their carefully selected library of 5,000 volumes and their quiet social relations attested wide culture.

Tragically his body lacked the vigor of his personality and mind.

S. F. ACREE

WASHINGTON, D. C.

EDWARD PAYSON VAN DUZEE

EDWARD PAYSON VAN DUZEE, curator of the department of entomology, California Academy of Sciences, San Francisco, died on June 2, 1940, after a brief illness. He was born in New York City on April 6, 1861, was educated in public and private schools, served as assistant librarian and as librarian of the Grosvenor Library of Buffalo, New York, for 27 years, going to California in 1912. After two years spent in San Diego and in the Scripps Institution at La Jolla, he became an instructor in entomology in the University of California for 1914–16, and was appointed curator of the department of entomology and assistant librarian in the California Academy of Sciences in 1916.

As a student of entomology from his earliest youth he became a leader in faunistic studies, especially in the Hemiptera, his list of scientific publications reaching 165 in number. His "Catalogue of the Hemiptera North of Mexico," a volume of over 900 pages published by the University of California in 1897, stands as an example of scholarly scientific research and is invaluable to entomologists everywhere. Under his guidance the entomological collections of the California Academy of Sciences have grown from some 30,000 to well over 1,000,000 specimens and form a national center of research. He founded the *Pan Pacific Entomologist* in 1924, and continued as its editor-in-chief until the past few months, when his failing strength compelled its relinquishment.

His kindly, helpful attitude toward his colleagues, and especially toward younger students of insects, and his contagious enthusiasm and self-sacrificing devotion to his work will cause his memory to be cherished by all who knew him, while the department he built up will remain his enduring monument.

F. M. MACFARLAND

STANFORD UNIVERSITY

RECENT DEATHS

CHESTER O. REED, professor of agricultural engineering at the Ohio State University, died on June 11. He was fifty-four years of age.

DR. MELVIN RANDOLPH GILMORE, curator of ethnology in the Museum of Anthropology of the University of Michigan, died on July 25 at the age of seventy-two years.

PROFESSOR COUNT GIOVANNI LORENZINI, president

of the Italian Biochemical Institute at Milan, known for his studies of vitamins, was killed in an automobile accident on July 24.

Nature reports the death of Dr. L. S. Bagster, professor of chemistry in the University of Queensland, Brisbane, aged fifty-three years, and of Dr. Samuel Klein, professor of the historical geography of Palestine in the Hebrew University, Jerusalem.

SCIENTIFIC EVENTS

THE HALL OF INVENTIONS AT THE WORLD'S FAIR

THE Hall of Inventions at the World's Fair in New York celebrates the one hundred and fiftieth birthday of the U. S. Patent System. It illustrates the beginnings of industrial and technical life in America and includes early working models of devices and machines from which many of the most important industries have developed.

There are 4,000 items presented in the various exhibits. These include the cotton gin, sewing machine, automobile, railway devices, production machinery and household helps. One of the displays consists of a scale model of the snow cruiser now with Byrd's Expedition in Antarctica. Patented and trademarked formulas, and even patented plants and flowers, have their part in the exhibit.

It was the practice formerly to submit actual working models when applying for a patent. Many of these original models are on exhibition in the Hall of Inventions. They come from the Drexel Institute and the Franklin Institute; the Massachusetts Institute of Technology; the Stevens Institute of Technology, and the Smithsonian Institution.

There is also a fully equipped experimental shop where machines and projects are built from early blueprints. The shop includes 6″ and 10″ lathes, drill presses, shapers, grinders, vises, tools and attachments manufactured by the Atlas Press Company, Kalamazoo, Mich.

The exhibit is open from 10 A.M. to 10 P.M. daily.

THE AMERICAN COORDINATING COMMITTEE ON CORROSION

THE second annual meeting of the American Coordinating Committee on Corrosion was held on June 27, at Atlantic City. Dr. F. N. Speller, of Pittsburgh, consultant on corrosion, was formally named chairman for the coming year. Dr. R. M. Burns, of the Bell Telephone Laboratories, was named vice-chairman and Dr. G. H. Young, Mellon Institute of Industrial Research, secretary-treasurer.

The committee was organized two years ago to coordinate research activities in the field, and is patterned after similar organizations in England, Holland, Belgium and other countries abroad. Cooperation has been promised by all the major companies and independent laboratories that are actively engaged in corrosion investigations.

The committee is at present composed of official delegates from the American Chemical Society, the American Electroplaters Society, the American Foundrymen's Association, the American Gas Association, the American Institute of Chemical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Heating and Ventilating Engineers, the American Society of Mechanical Engineers, the American Society of Refrigerating Engineers, the American Society for Metals, the American Society for Testing Materials, the American Water Works Association, Battelle Memorial Institute, the Electrochemical Society, Mellon Institute of Industrial Research, the National Bureau of Standards, the National District Heating Association, the Society of Automotive Engineers and the Technical Association of the Pulp and Paper Industry.

At the meeting just passed, the American Welding Society, the Chemical Foundation, the Engineering Foundation and the National Research Council were also elected to membership.

TRIBUTE TO THE LATE DR. W. E. BRITTON, STATE ENTOMOLOGIST OF CONNECTICUT

A TRIBUTE and biographical sketch of the late Dr. W. E. Britton, the first state entomologist of Connecticut, is printed as an introduction to the thirty-ninth report on entomological work in Connecticut. It is the first report of Dr. Roger B. Friend, Dr. Britton's successor.

The report, which occupies 112 pages, contains, in addition to the introduction, a complete review of the year in entomology, sections of which were contributed by members of the staff. There are chapters on the insect record of 1939; reports on inspection of nurseries and bees, control of the gipsy-moth, the Japanese beetle, carrier of the Dutch elm disease; miscellaneous insect notes, and the department publications of the year.

This report is the latest of an unbroken series that has been published annually since the office of state entomologist was created by an act of the General Assembly in 1901. Dr. Friend writes:

> The state entomologist undertook his duties with energetic enthusiasm. He not only met various situations as they arose, but, prophetically, anticipated future problems and was prepared for emergencies. The demands on his

office increased as time went on, and the high quality of service rendered the people of the state engendered confidence in the work. With the increase of personnel to the staff and a multiplication of tasks, including research, control, quarantine, publication and the manifold activities involved in keeping track of insect pests and informing the people of the state about them, Dr. Britton's work gradually shifted in emphasis from research to administration.

In conclusion, he sums up the character of Dr. Britton in the following words:

A man's accomplishments depend on his personal qualities. Dr. Britton adhered to sound principles in his personal affairs and his relations to members of his staff and other associates in his profession, as well as to his community. Although inherently conservative and personally rigidly adherent to an ethical code which demanded honesty, integrity and candor, he was at the same time liberal in his judgment, tolerant in his decisions, disinterested and generous. To the members of his staff he was always stimulating. Interested in every phase of their activities and demanding intelligent application to the task at hand, faithful performance, loyalty and devotion to the public welfare, at the same time he neither interfered unduly in their work nor evaded responsibility for their acts. He was excessively careful in giving them credit for whatever they accomplished. Those outside the Experiment Station with whom the state entomologist cooperated in many phases of entomological work found him an ideal associate, and the community in which he lived benefited by his presence. In spite of his manifold tasks and remarkable productivity, he took the oscillations of fortune philosophically, confident of the outcome, unperturbed, saved from fretfulness by a serene disposition and a sense of humor.

IN HONOR OF JULIUS HERMAN FRANDSEN

AT the thirty-fifth annual meeting, held at Lafayette, Ind., of the American Dairy Science Association, a tribute was paid to Professor Julius Herman Frandsen, professor of dairy industry at the Massachusetts State College, "in recognition of outstanding service to dairy science in America, particularly in the conception, advocacy and establishment of the *Journal of Dairy Science* which he so carefully nurtured and successfully edited and managed for eleven years—a substantial and far-reaching contribution of inestimable value to the advancement of dairy research, teaching and practice."

Dr. H. B. Ellenberger, professor of animal and dairy husbandry at the University of Vermont and head of the department, presented the tribute. He stated that this was the third time that such an honorary tribute had been paid by the association to one of its members. In 1933 Professor Wilber J. Fraser, of Illinois, founder of the association, was presented with a framed "token of appreciation" for his "clear vision of the possibilities in advancing the cause of scientific dairying through a closer organization of the workers in the field" and for eminent service to the industry. In 1934 a similar "tribute" was presented to Dr. Otto F. Hunziker, of Chicago, for "outstanding leadership in dairy research and education" and in association affairs, and in 1935 a framed "tribute" was given to Dr. Martin Mortensen, of Iowa, in recognition of his "eminent service to the dairy industry . . . and his devotion to our association."

Dr. Ellenberger then gave the following particulars in regard to Dr. Frandsen's life and work:

Professor Frandsen was born in Story County, Iowa, the central county of the central state of the cornbelt. He was raised on a farm and has been associated with dairying in one form or another all his life. He is a graduate of Iowa State College in the class of 1902, where I was a student with him and from which he received a Master of Science degree in 1904. In 1906 Matilda Madson, another I.S.C. graduate, became his wife and very active life partner.

From 1904 to 1907 Professor Frandsen was engaged in commercial work with Professor Mortensen. In 1907 he was appointed the first professor of dairy industry at the University of Idaho, where he remained as head of the department until 1911 when he became professor of dairy husbandry at the University of Nebraska. While there he was instrumental in securing the erection of the dairy building, dedicated in 1917, then recognized as the finest college dairy building in the country and still ranking as one of the best.

Leaving the University of Nebraska in 1921 to become dairy editor of farm papers, he again returned to teaching and research in 1926 as professor of dairy industry at the Massachusetts State College, the position which he now holds.

Professor Frandsen served as president of the Official Dairy Instructors' Association, as this organization was then named, during 1913 and 1914. In his presidential address of 1913 he made a strong plea for the establishment of a journal to be published by our association in the interest of dairy science and research. From that time through 1914–16, he at every opportunity advocated the establishment of such a journal. This ambition was realized, when at its 1916 annual meeting, this association approved the establishment of the *Journal of Dairy Science* and designated Professor Frandsen as editor-in-chief. It is interesting to note that this action was taken in Flint Laboratory, Amherst, Massachusetts, the building in which Professor Frandsen now has his office.

As editor of the *Journal of Dairy Science* from May, 1917, to January, 1928, Professor Frandsen has been the means of arousing, encouraging and advancing dairy research in a way and to an extent now recognized as outstanding and important.

APPOINTMENT OF DR. BRUNO ROSSI AT CORNELL UNIVERSITY

DR. BRUNO ROSSI, research associate at the University of Chicago, formerly professor and head of the

department of physics at the University of Padua, has been appointed associate professor of physics at Cornell University. Dr. Rossi lost his position at Padua in 1938 when the racial laws went into effect. After spending some time at the Bohr laboratory in Copenhagen, he received a fellowship at the University of Manchester, working with P. M. S. Blackett, Langworthy professor of physics in the university. A correspondent writes:

Dr. Rossi is recognized as one of the five leading investigators in the field of cosmic radiation. In recent years he has published more than thirty papers on the subject and has conducted an incredible number of investigations, some of which are yet unpublished. Dr. Hans Bethe, of Cornell University, with whom Dr. Rossi will be associated, states, "There is hardly any paper on the subject of cosmic radiation in which Rossi's name is not quoted repeatedly." As a result of his research the original, as well as the most exact and recent work on the production of "showers" in cosmic radiation was produced. This led to a confirmation of the quantum theory of radiation up to tremendous energies of electron volts.

Dr. Rossi has been associated with many of the greatest physicists. Together with Fermi, Nobel-Prize laureate, now of Columbia University, in 1930 he calculated the effect of the magnetic field of the earth on cosmic ray particles, long before work on this problem was undertaken in America. Professor Arthur H. Compton, who called him to the University of Chicago, entrusted to him the planning of a large part of the extensive ray work done at that institution.

At Cornell, Dr. Rossi will develop cosmic ray research, and will work closely with Dr. Bethe and Dr. Robert F. Bacher in nuclear physics and with Dr. Lyman G. Parratt in x-rays. He will also collaborate with Professor Peter J. W. Debye, who joined the faculty as head of the department of chemistry on July 1.

In 1938 Dr. Rossi married Miss Nora Lombroso, granddaughter of Lombroso, the well-known Italian criminologist. They will establish their residence in Ithaca in time for the fall opening of the university.

SCIENTIFIC NOTES AND NEWS

THE honorary degree of doctor of science was conferred on Dr. L. O. Grondahl, director of research and engineering of the Union Switch and Signal Company, Pittsburgh, Pa., at the commencement exercises of St. Olaf College, Northfield, Minn. Dr. Grondahl is an alumnus of the college.

DR. GUSTAV EGLOFF, director of research for the Universal Oil Products Company, was awarded the degree of doctor of science at the commencement exercises at the Armour Institute of Technology in recognition of "his outstanding contributions in the field of petroleum refining."

ACCORDING to *Nature* the Franqui Prize of half a million francs has been awarded by the Franqui Foundation Committee to Dr. Pierre Nolf, professor of pathology and therapeutics at Liège, for his contributions to science.

DR. H. VINCENT, professor at the Collège de France, formerly inspector-general of the Health Service of the French Army, has been elected vice-president of the Paris Academy of Sciences.

AT the recent meeting in New York City of the American Society of Clinical Pathology, Dr. A. V. St. George, of New York, was inducted into the office of president for the coming year. The following officers were elected: *President-elect,* Dr. J. L. Lattimore, Topeka, Kans.; *Vice-president,* Dr. Ralph G. Stillman, New York City; *Executive Committee,* Dr. L. W. Larson, Bismarck, N. D.; Dr. C. H. Manlove, Portland, Ore.; *Board of Censors,* Dr. R. F. Peterson, Butte, Mont.; Dr. L. C. Todd, Charlotte, N. C.; *Board of Registry,* Dr. L. G. Montgomery, Muncie, Ind.; Dr. I. Davidsohn, Chicago. The Gold Medal for excellence in the scientific exhibit was awarded to Dr. John Eiman and Dr. Charles G. Grosscup for their exhibit on "Fundamental Factors Governing the State of Hydration of the Body in Health and Disease."

AT the forty-third annual meeting of the American Society for Testing Materials on June 25, Dr. William M. Barr, chief chemical and metallurgical engineer of the Union Pacific Railroad Company, was elected president; Herbert J. Ball, vice-president, and Roger C. Griffin, Dr. Paul D. Merica, Jerome Strauss, Stanton Walker and C. H. Fellows, members of the executive committee.

DR. ARTHUR S. GALE, of the University of Rochester, has been made dean emeritus of the physical sciences.

DR. ALBERT P. MATHEWS, since 1918 Andrew Carnegie professor of biochemistry in the College of Medicine of the University of Cincinnati, retired on July 1. He has been succeeded by Dr. Milan A. Logan, assistant professor of biochemistry at Harvard University.

DR. C. W. METZ, member of the staff of the Carnegie Institution of Washington, has been appointed professor and head of the department of zoology at the University of Pennsylvania. He succeeds Dr. C. E. McClung, who retired at the close of the academic year.

DR. PAUL C. MANGELSDORF, vice-director of the

Texas Agricultural Experiment Station, has been appointed professor of botany at Harvard University and assistant director of the Botanical Museum. Dr. Sheldon C. Reed, lecturer in genetics at McGill University, has been appointed instructor in biology.

DR. THOMAS P. COOPER, dean of the College of Agriculture of the University of Kentucky and director of the Experiment Station, has been made acting president of the university. Dr. Cooper will divide the time between his office in the experiment station and the president's office.

DR. DUGALD E. S. BROWN, assistant professor of physiology at the New York University College of Medicine, has been appointed professor and head of the department of physiology of the College of Dentistry.

DR. WILLIAM CRAMER, British delegate to the International Cancer Congress at Atlantic City last September and for over twenty-five years a member of the Imperial Cancer Research Fund, London, has joined the staff of the Barnard Free Skin and Cancer Hospital in St. Louis.

DR. H. MARK, formerly of the University of Vienna, has been appointed professor of organic chemistry at the Polytechnic Institute of Brooklyn. He will direct research in the field of high molecular weight compounds. During the year 1940–41, he will lecture on the physical aspects of organic chemistry and on the chemistry of rubber.

DR. PAUL V. MCKINNEY, senior fellow in the work of the Texas Gulf Sulphur Company at the Mellon Institute of Industrial Research, has been appointed director of research of the Neville Company, Pittsburgh, Pa. He will be engaged in a study of the production of synthetic resins and organic chemicals. The Neville Company is doubling the space devoted to research.

DR. A. E. ALEXANDER, industrial fellow at the Mellon Institute, Pittsburgh, has left to take charge of the Bureau of Natural Pearl Information, New York City. This gem and pearl testing laboratory is supported by a group of New York retail and wholesale jewelers.

DR. GRIFFITH C. EVANS, professor of mathematics at the University of California, has been appointed a member of the National Research Council in the division of the physical sciences, as a representative of the American Mathematical Society. The appointment was effective on July 1 and is for a three-year term.

THE Rockefeller Foundation has renewed a grant of $3,000 a year for three years to Duke University in support of the study of the physical chemistry of proteins by Dr. Hans Neurath, of the department of biochemistry of the School of Medicine.

THE Committee on Scientific Research of the American Medical Association has awarded grants to Dr. Herman Kabat and to Dr. Charles F. Code, both of the department of physiology of the University of Minnesota, the former for an investigation of the nervous component in traumatic shock, and the latter in aid of studies on the possible slow absorption of injected desoxycorticosterone from a mixture with beeswax. A final grant has been made to supplement an assignment made a year ago to Dr. Owen H. Wangensteen, professor and head of the department of surgery of the hospitals of the University of Minnesota, to continue research relating to the physiologic rationale of operations performed for the relief of duodenal and gastric ulcer. Dr. Howard Curl, assistant professor of anatomy at the University of Tennessee, has received a grant for a roentgenological study of the normal gall bladder.

JAMES F. WILSON, professor of animal husbandry at the University of California, sailed on July 20 for Australia, where he will spend a six months' leave of absence in studying wool production. Before leaving he was presented by the California Wool Growers Association with a set of luggage, "in appreciation of twenty years of service" to the industry.

DR. THOMAS J. LEBLANC, of the College of Medicine of the University of Cincinnati, and Dr. Elliston Farrell, of Long Island Medical College, with a number of their students are attending the six weeks summer school of the Puerto Rico School of Tropical Medicine.

AT the Conference on Nuclear Physics to be held at Indiana University to celebrate the opening of the new Physics Building, Swain Hall, on Friday and Saturday, October 25 and 26, special lectures will be given by Professors H. A. Bethe, Cornell University; Gregory Breit, University of Wisconsin; Lee A. DuBridge, University of Rochester, and I. I. Rabi, Columbia University.

DR. OSCAR RIDDLE, of the Carnegie Institution Station for Experimental Evolution at Cold Spring Harbor, N. Y., gave an address on "Hormones" before the Summer Science Conference at Syracuse University on July 18.

THE Genetics Society of America will hold a meeting at Woods Hole, Mass., on August 29 and 30. Summer meetings have been held annually at the Marine Biological Laboratory since 1934, with the exception of last year, when many of the members were attending the seventh International Congress of Genetics at Edinburgh. A clam-bake will be held on the evening

of the twenty-ninth. Dr. Leon J. Cole is president of the society and Dr. E. W. Lindstrom is secretary-treasurer.

A MEETING of the Eastern Division of the American Philosophical Association will be held at the University of Pennsylvania on December 26, 27 and 28. Following the meeting there will be a symposium on "Science and Values" held in conjunction with the meeting of the American Association for the Advancement of Science.

THE regular summer meeting of the Pennsylvania Academy of Science is to be held at Gettysburg on August 9 and 10. Field trips to points of scientific interest in the vicinity are planned. Information can be obtained from the secretary of the society, Dr. V. Earl Light, Lebanon Valley College, Annville.

IN connection with the national defense program the U. S. Civil Service Commission is endeavoring to secure well-qualified metallurgists and metallurgical engineers for employment in the Federal Government. Examinations have been announced to fill these positions, covering six grades, with salaries ranging from $2,000 for the junior grades to $5,600 for the principal grades. Applications must be filed not later than August 22. Competitive examinations to fill the position of civil engineer cover four grades, with salaries ranging from $2,600 a year for the assistant grade to $4,600 a year for the senior grade. Applications should be on file at the Washington office of the commission not later than August 29. Further information as to the requirements for the various grades and application forms may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the U. S. Civil Service Commission, Washington, D. C.

THE Armour Institute of Technology and the Lewis Institute of Chicago were consolidated on July 24 under the name of the Illinois Institute of Technology. Henry T. Heald, who has been for two years head of the Armour Institute, was elected president. James D. Cunningham, chairman of the board of the Armour Institute, was named chairman of the board; Alexander D. Bailey, chairman of the trustees of the Lewis Institute, was elected vice-chairman.

THE National Cancer Institute, of the National Institute of Health of the U. S. Public Health Service, announces the establishment of *The Journal of the National Cancer Institute* as the official organ of the institute. The new journal, which will be issued bimonthly, will contain articles by the members of the staff on the various lines of cancer research work carried on by the institute. The first issue will include papers on the federal cancer control program, approaches to cancer research, the effect of various hydrocarbons in producing tumors in mice and studies on normal and cancerous tissues. The journal will be sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. It will be distributed free to a limited number of medical schools, to workers in the field of cancer research, to research institutes interested in cancer, to a limited number of surgeons, as well as to certain government depositories and to journals making suitable exchanges.

IN connection with the celebration of the fiftieth anniversary of the University of Chicago, which begins on October 1, culminating in an academic festival in September, 1941, thirty-one learned societies, having together more than 15,000 members, will meet at the university. Dr. Frederic Woodward, vice-president emeritus, is director of the celebration. Among the first of the societies to meet in Chicago are the Clinical College of the American College of Surgeons and the International Anesthesia Research Society, from October 21 to 25. The American Association of Anatomists will meet from April 9 to 11, 1941.

BARLEY FIELD DAY, sponsored by the College of Agriculture of the University of Wisconsin, was held on July 15. Over two hundred visitors representing all phases of the barley handling, selling, malting, brewing, distilling and food industries were in attendance. The morning was spent in inspecting the barley breeding and experimental work on the University Farms. A picnic luncheon furnished by the Malt Research Institute and the United States Maltsters Association was served at noon, followed by a discussion of the responsibility of the Agricultural Experiment Station in coordinating agricultural research with the industrial use of farm products by Dr. Chris. L. Christensen, dean and director of the Wisconsin College of Agriculture and the Wisconsin Agricultural Experiment Station. This was followed by a discussion of the barley breeding program by Professor H. L. Shands and the history of barley improvement in the state by Professor B. D. Leith, both of the University of Wisconsin. The afternoon was spent in inspecting barley test plots and other experimental work. Those interested were given an opportunity to visit the experimental malting laboratory in the Agronomy Building.

THE first instalment of Central American collections of mammals, reptiles and invertebrate animals obtained on an expedition for the British Museum conducted by Ivan T. Sanderson, of Belize, British Honduras, has been received for deposit at the Field Museum of Natural History, Chicago, for the duration of the war. Mr. Sanderson, formerly of Cambridge, England, has conducted expeditions in many parts of Africa and the West Indies. At his request, identi-

fication of some of his material will be undertaken at the museum and some division of the collections will ultimately be made between the Field Museum and the British Museum.

DISCUSSION

NATIVE AND INTRODUCED LAND PLANARIANS IN THE UNITED STATES

THE land planarians characteristically inhabit humid forests in the tropical and subtropical zones of the earth where hundreds of species exist. In his classical monograph[1] von Graff listed 348 species (some, however, probably synonyms) and probably two hundred additional species have been described since that time. As great areas of the tropics remain unexplored with regard to this group of flatworms, it seems reasonable to suppose that the undescribed species at least equal the described ones in number.

The introduction of tropical land planarians into the north temperate zone with tropical plants appears inevitable, yet until recently only one species was known to have succeeded in establishing itself. This is the familiar *Bipalium kewense* Moseley, discovered in 1878 in the greenhouses of the Kew Gardens, near London. This animal is common in greenhouses and conservatories throughout Europe and the United States and also occurs in nature in a variety of tropical habitats, as Brazil, New Zealand, Australia, Samoa, Fiji, Madeira, Hawaii, China and Japan. Its original home is unknown, but may be inferred to have been somewhere in the Indo-Malay region, since the family Bipaliidae centers there. Specimens received for identification from the U. S. National Museum show that *Bipalium kewense* has become established out-of-doors in the West Indies and southern Florida.

Occasionally other exotic land planarians appear in greenhouses, but none is known to have persisted for any length of time. Thus several specimens of a species of *Desmorhynchus* (possibly from Madagascar) were taken in 1914–1916 in greenhouses of the U. S. Department of Agriculture in Washington, D. C.

In view of the general failure of exotic land planarians to maintain themselves in the north temperate zone, even in greenhouses, it is rather surprising to find that these animals have in recent years established themselves in Californian gardens and appear to be flourishing. Specimens of three different species have been received to date.[2] These comprise two species of *Geoplana* and one *Bipalium*. One of the *Geoplanas*, a small black species, turns out to be *G. mexicana* Hyman, 1939,[3] twice found at the Texas border on shipments of flowers from Mexico. Hence this species has been introduced into California from Mexico. The other *Geoplana*, a larger bluish-black form, and the *Bipalium*, light brown with a dark brown mid-dorsal stripe, do not appear to coincide with any described species. All three species are fully mature and are undoubtedly reproducing sexually in their adopted home. This point is of especial interest, since in general tropical land planarians when introduced into cooler climates fail to mature sexually and hence can not persist unless they are capable of some mode of asexual reproduction. The latter appears to explain the persistence of *Bipalium kewense*, since this species also has never been found with sex organs in temperate regions. The fact that the California forms are able to mature leads one to suspect that they are native to some adjacent, not fully tropical region, as Mexico or Central America.

Genuinely endemic land planarians do, however, occur in the north temperate zone; curiously enough, all these belong to the family Rhynchodemidae, and nearly all to the genus *Rhynchodemus*.[4] About 15 species have been described in Europe,[5] but the endemicity of some of these may be questioned, especially those known only from the Riviera, where there are many introduced plants. In the United States, two endemic rhynchodemids have been reported to the present time. These are *Rhynchodemus sylvaticus* (Leidy), 1851[6] and *R. atrocyaneus* Walton, 1912.[7] The former, small, slender, grayish with two dark stripes and with pointed head bearing a pair of large eyes, has been reported from Rhode Island, Pennsylvania, and Ohio, under pots and boards in gardens and meadows, and under logs and bark in woods. Apparently not uncommon in former years, this species seems not to have been collected in the last twenty years, and attempts to obtain specimens from Philadelphia, the type locality, have so far proved futile.[8] Of *R. atrocyaneus* nothing was known but the original description, which states that two specimens were found at Gambier, Ohio, 20 cm long and of a uni-

[1] "Monographie der Turbellarien. II. Tricladida Terricola." 1899.

[2] Kindly sent by Dr. M. W. de Laubenfels, Pasadena, and John L. Mohr, Berkeley.

[3] *Proc. U. S. Nat. Mus.*, 86: 425.

[4] *Microplana* has recently been shown to be a synonym of *Rhynchodemus* (Schneider, *Zool. Jahrb. Abt. System.*, 67: 179).

[5] Recently listed by Arndt, *Zoogeographica*, 2: 375.

[6] *Proc. Acad. Nat. Sci. Phila.*, 5: 239, 289; 10: 171.

[7] SCIENCE, 25: 732.

[8] Dr. J. Percy Moore kindly tried to find some specimens for me.

formly dark blue color. I have come into possession of a set of serial sections of this species found among the effects of Dr. Walton,[9] and these yield some additional information but unfortunately the specimen is sexually immature.

I have now to report the finding in woods of the Appalachian Mountains of a new endemic rhynchodemid. To date three specimens have come to hand,[10] collected in Maryland, Virginia, and West Virginia, respectively. All three are at or near sexual maturity, and study of the copulatory apparatus in serial section has shown that the animal belongs to the genus *Diporodemus* Hyman, 1938.[11] This genus differs from *Rhynchodemus* in that in addition to the usual common genital pore opening in the midventral line there is a female or vaginal pore to one side of the median line by which the copulatory bursa opens to the exterior. I established this genus for a species from Yucatan, Mexico. Since then a second species of the genus has been found on Barro Colorado Island, Canal Zone,[12] and now the Appalachian form is the third member. All three species are practically identical in external appearance. They are black or brownish black, plump, cylindroid and about 15 mm in length; the Panamanian and Appalachian species are further alike in that the eyes are degenerate, detectable only in sections, and the creeping sole continues onto the ventral surface of the head as a glandular cleft, probably acting as an adhesive organ in food capture. The Yucatan and Appalachian species have also in common a pair of longitudinal sensory tracts on the cephalic ventral surface.

A complete account of these endemic and introduced land planarians will be published elsewhere.

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CONCERNING PURE CULTURES OF SPIRILLUM

ALTHOUGH bacteriologists have long been interested in spiral bacteria, very few workers have reported success in the isolation of pure cultures. Esmarch,[1] Beijerinck,[2] Kutscher,[3] Bonhoff,[4] Dimitroff[5] and Giesberger[6] have described methods by which they were able to isolate several species from water and feces.

Several months ago, the writer wished to procure some species of this genus for cytological study, but after considerable correspondence, found that such cultures are not available. It now seems probable that all or most of the pure cultures isolated by earlier investigators have been lost. *Rhodospirillum rubrum* (Esmarch) Molich and *Spirillum virginianum* Dimitroff were obtained from the American Type Culture Collection. The cells of these species are rather small, however, and not well suited for cytological study. Since pure cultures could not be obtained from culture collections, isolation of the desired species from original sources was accomplished.

This note is written to correct a general impression that the isolation of pure cultures of Spirillum is a difficult matter. My experience has been that several species are readily isolated from raw cultures by simple routine methods employed for other groups of bacteria. Suitable raw cultures must be obtained by enrichment methods, but this is not difficult since most surface waters appear to contain a variety of species of this genus.

Several culture media were tested for enrichment, but none was found more satisfactory than hay or other plant infusions. Decaying cultures of fresh water algae usually contain many spiral bacteria. Spiral cells are rarely seen in the early stages of decomposition, but as the culture ages they become more and more abundant until, at times, the surface pellicle becomes a swarming mass in which they predominate. This peak period may be reached within a few days but generally requires from one to three weeks. Raw cultures are generally rather short lived.

During the swarming period, pure cultures are readily isolated by streaking out on the surface of beef extract peptone agar. The colonies appear promptly and are readily recognized by microscopic examination *in situ*. By this method the following species were isolated from creek and pond waters in the vicinity of Austin, Texas: *Sp. serpens* (Müller) Winter, *Sp. undula* (Müller) Ehrenberg, *Sp. tenue* (Müller) Ehrenberg, *Sp. itersonii* Giesberger. The most common species in this vicinity proved to be *Sp. serpens*.

Although rich raw cultures of *Sp. volutans* Ehbg. became available on two occasions, it was not possible to obtain pure cultures since no colonies developed on the streaked plates or in poured plates with semi-solid agar as the plating medium. The giant spiral cells of this species could be seen lying on the agar surface,

[9] Dr. H. I. Strohecker, of Kenyon College, Gambier, Ohio, kindly forwarded to me a box of slides of land planarians made by Dr. Walton.

[10] Sent for identification by the U. S. National Museum and collected by Dr. J. P. E. Morrison of that institution.

[11] "Fauna of the Caves of Yucatan," Carnegie Inst. Wash., Publ. No. 491.

[12] A collection of land planarians from Barro Colorado Island was kindly sent to me for identification by E. C. Williams, Jr., of Northwestern University; description in press.

[1] E. von Esmarch, *Centr. f. Bakt.*, 1: 225, 1887.

[2] M. W. Beijerinck, *Centr. f. Bakt.*, 14: 827, 1893.

[3] Kutscher, *Zeitschr. f. Hygiene*, 20: 46, 1895.

[4] Bonhoff, *Archiv f. Hygiene*, 26: 162, 1896.

[5] V. T. Dimitroff, *Jour. Bact.*, 12: 19, 1926.

[6] G. Giesberger, Delft thesis, W. D. Meinema, pp. 1–136, 1936.

but there were never any indications of growth or cell division.

There has been but a single claim for isolation of this species. Kutscher identified one of his pure cultures as *Sp. volutans* Ehbg., but his identification was questioned by Migula.[7] According to Migula, the organism isolated by Kutscher should be designated as *Sp. giganteum* (Kutscher) Migula. This has caused considerable confusion since many workers employed Kutscher's organism in their studies on the cytology and physiology of bacteria, and referred to the organism as *Sp. volutans*. The illustrations by these workers bear little or no resemblance to the true *Sp. volutans* Ehbg. There seems, therefore, no reason to believe that this species has yet been isolated.

A cytological study of the several species has been completed and will be published elsewhere. The pure cultures have been deposited in the American Type Culture Collection.

I. M. LEWIS

THE UNIVERSITY OF TEXAS

OXIDATION OF SULFANILIC AND ARSANILIC COMPOUNDS BY NASCENT HYDROGEN PEROXIDE

OTTENBERG and Fox[1] have reported that colored products appeared following ultra-violet irradiation of dilute solutions of sulfanilamide. The blue-violet products seemed of particular interest. Fox, Cline and Ottenberg[2] as well as Rimington and Hemmings[3] emphasized that the formation of the blue derivative involves an oxidation of sulfanilamide, since the presence of oxygen is necessary for the formation of the blue-colored irradiation product.

Oxidation of sulfanilamide by chemical means to a blue product had not been accomplished, when Fox, Cline and Ottenberg published their article.[2] In the meantime I[4] have reported that, under certain experimental conditions, solutions of sulfanilamide treated with oxygen form hydrogen peroxide and a blue-violet compound which is reversibly reducible and oxidizable. The hypothesis was advanced that the formation of this blue-colored substance may be due to the influence of nascent H_2O_2. In further experiments being published in detail elsewhere it was found that nascent hydrogen peroxide as formed on autoxidation of hydrazine solutions (Gilbert,[5] Schales[6]), in presence of cupric ions oxidizes sulfanilamide promptly to blue-violet derivatives. These substances are reversibly reducible and oxidizable, and, when freshly formed, extractable with amyl and butyl alcohols and other organic solvents. They are comparatively stable in those solvents but unstable in water, losing extractability and changing color.

Among related compounds studied arsanilic acid behaves in a manner comparable with sulfanilamide. The blue-violet butyl alcoholic extracts obtained from sulfanilamide and arsanilate showed an absorption spectrum practically identical in shape (maximum absorption at about 590 mμ). The identity of the two blue compounds is probable. It would be expected that if these compounds had retained their characteristic side-chains there would be a greater difference in the absorption spectra. If the oxidation products are identical the side-chains must have been lost. It is suggested that therapeutically or toxically active derivatives formed *in vivo* also may lack the characteristic side-chains of the original substance.

Rosenthal and Bauer[7] recently published in this journal the extremely interesting observations that on oxidation of sulfanilamide by means of ultra-violet irradiation or ferric chloride and hydrogen peroxide the sulfonamide group is split off. My studies of the spectroscopical behavior of the blue oxidation products obtained from sulfanilamide and from atoxyl lead to a similar conclusion.

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SCIENTIFIC BOOKS

THE CALCULUS

Introduction to the Calculus. By ARNOLD DRESDEN. xii + 428 pp. New York: Henry Holt and Company. 1940. $3.40.

THIS book, as its title indicates, is designed as an introduction to the calculus, presumably for students of sophomore age. It is particularly noteworthy, inasmuch as it is the first serious attempt among American text-books to introduce the subject in a rigorous and logical manner. The first two chapters, about sixty pages, of the book, are devoted to the essentials of the

[7] W. Migula, "System der Bakterien." Jena, 1900.

[1] R. Ottenberg and Ch. L. Fox, Jr., *Proc. Soc. Exp. Biol. and Med.*, 38: 479–481, 1938.

[2] Ch. L. Fox, Jr., J. E. Cline and R. Ottenberg, *Jour. Pharmacol. and Exp. Therap.*, 66: 99–106, 1939.

[3] Cl. Rimington and A. W. Hemmings, *Biochem. Jour.*, 33: 960–977, 1939.

[4] G. Barkan, *Proc. Soc. Exp. Biol. and Med.*, 41: 535–537, 1939.

[5] E. C. Gilbert, *Jour. Am. Chem. Soc.*, 51: 2744–2751, 1929.

[6] O. Schales, *Ber. Dtsch. Chem. Ges.*, 71: 447–460, 1938.

[7] S. M. Rosenthal and H. Bauer, SCIENCE, 91: 2369, 509, May 24, 1940.

theory of point sets and of continuous functions. From that point on the book treats in more or less standard order the usual topics of the differential and integral calculus, with the exception that the proofs are placed on a more rigorous footing. These proofs are not always given in complete detail. They are deliberately curtailed in order to keep the essentials clearly in focus. In some cases the parts omitted are included in the exercises. For example, the derivation of the formula for the derivative of a function of a function, left incomplete in most text-books, is here carried to a point so near completion that the student can fill in the details. The book does not entirely solve the logical difficulties of the teacher resulting from the necessity of a choice in the order of topics. In some cases forward references are necessary. Thus the "Law of the Mean" is used on page 92, while it is proved on page 117.

The topics are concerned mostly with functions of one variable. There is, however, one chapter on double and triple integration. Also, partial differentiation is defined and used (in Chapter 4) to obtain the derivatives of functions defined implicitly. The book ends with two chapters on differential equations.

A problem which confronts the teacher of students who wish to make use of the calculus in the applied sciences is how to introduce the subject of integration early enough. The text under review solves it by introducing problems on inverse differentiation in with those on differentiation. The definite integral is introduced in Chapter 12, in characteristic fashion, with the proof that its defining limit exists for any continuous function! The author admits that the student, meeting the subject for the first time, might wish to omit such a proof. In fact, he points out that the traditional course "can be extracted from the book by omitting the proofs of theorems." In spite of the rigorous point of view, a lively and interesting style is maintained. Witness the term "principle of the flycatcher."

The reviewer regrets that the very useful exact remainder theorem for Taylor's theorem (expressing the remainder as a definite integral) is omitted here as in most standard text-books. He also feels that the utility of the book would be slightly increased if the statement of theorems were italicized.

This book presents the calculus as the teacher would like to present it to his classes, in logical order. We have hitherto assumed in this country that this most pleasant method of lecturing was not the most efficient way of teaching, that maximum enjoyment for the instructor might mean minimum enjoyment for the mediocre student. The author believes otherwise, that the present type of treatment should increase the student's enjoyment as well as his power to use the material. He bases his belief on his own experience as a teacher in this country, and on his acquaintance with young Europeans of the age of American sophomores. It is devoutly to be wished that he is right and that others who use the book will make similar findings.

D. V. WIDDER

IMAGE TRANSMISSION

Television—the Electronics of Image Transmission. By V. K. ZWORYKIN and G. A. MORTON. ix + 646 pp. New York: John Wiley and Sons, Inc. 1940.

THIS book is designed to condense and summarize in a readily accessible form the extensive literature which has already grown up in the field of television. The subject-matter is divided into four main sections. The first part deals with the fundamental processes and phenomena upon which the art of television is based. The second part discusses the general principles of television and the necessary relationships between the optical image and the transmitted radio image. The third portion deals with the individual components of the complete television system as devised in the RCA laboratories, and the fourth portion describes the equipment of the RCA-NBC television project. The first two sections will be of most interest to the general scientific reader, for in these parts are contained all that is necessary for a detailed understanding of the science of television as practiced to-day. The other two sections will be useful to those having an interest in the finer details of the subject.

The authors are to be particularly congratulated upon the extremely clear and concise exposition of the fundamental physical principles which occupy the first five chapters of the book. These chapters cover the emission of electrons from solids, fluorescent materials, electron optics and modern high-vacuum technique in the short space of 150 pages. Most physicists could read these pages with profit.

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REPORTS

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

MECHANICAL engineers throughout the United States and Canada are observing this year the sixtieth anniversary of the founding of their professional organization, the American Society of Mechanical Engineers, which to-day has 15,000 members and maintains headquarters in New York City and 71 school sections in va-

rious industrial areas. The story of the growth of the society coincides with the period in American industrial history in which the greatest mechanical developments have occurred, much of which have been made possible through the efforts of the society and its members, whose names would fill many pages. Their achievements cover a myriad of fields, chief of which are air conditioning, aeronautics, electric machinery, engineering research, metals, fuels, hydraulic turbines, internal-combustion engines, machine tools, naval improvements, ordnance material, petroleum, plastics, printing presses, pumps, railroads, scientific management, steam power, textiles and woodworking machinery.

It was on April 7, 1880, that 80 mechanical engineers organized the American Society of Mechanical Engineers, which had an initial membership of 189. As early as then, the founder members promulgated the present objectives of their engineering organization, which are to promote the art and science of mechanical engineering and the allied arts and sciences; to encourage original research; to foster engineering education; to advance the standards of engineering; to promote the intercourse of engineers among themselves and with allied technologists, and severally and in cooperation with other engineering and technical societies to broaden the usefulness of the engineering profession to industry, community and world. As officers of the new society, there were elected by those present a representative group of engineers, headed by President Robert Henry Thurston, pioneer educator in mechanical engineering. In 1883, Frederick Remsen Hutton, professor of mechanical engineering at Columbia University, became the first regular secretary, a part-time position that he held until 1906.

The early history of the society reflects the earnest endeavors of its slowly increasing membership to organize for the purposes enunciated by the founder members. Meetings were held, papers and discussions were presented and published and standards for material specifications and codes for recommended practice in a number of fields of testing were undertaken. Shortly after the turn of the century, a new spirit began to manifest itself in the organization. The rapid spread of membership throughout the country and the realization by engineers in many industrial centers that great benefits would result from local organizations culminated in 1904 in the establishment in Milwaukee of the first local section of the society. This movement led to the organization of others, until to-day there are 71 such groups in the United States and Canada.

The splendid gift by Andrew Carnegie of an engineering societies building in New York City, dedicated in 1906, gave impetus to widening influences and brought with it a realization that greater obligations had been placed upon the society. With the occupancy of the new headquarters in the building and the appointment of Calvin W. Rice as full-time secretary, a second period of growth began.

This second period of development was marked by the increase in the society's activities and their diversity, and a rapid growth of membership. Cooperation with other engineering bodies, in this country and abroad; more frequent meetings; the broadening of the field of professional interest; realization of the obligation of service in civic and social progress; increased activity in standardization, research, codes of recommended practice and safety; greater activity in local sections and student branches, the first of which was authorized in 1908 and to-day number 117 with 6,500 student members; and more extensive and more diversified publications have been some of the fruits of this growth. In 1919, from a recognition of the ever-broadening technical interests of the society's members came the 16 professional divisions under whose auspices the professional work of the society in the various branches of mechanical engineering is now carried on. National meetings, each devoted to a single subject but drawing participants from the country at large, were instituted to augment the more general meetings of the society in various cities in which all divisions take part and the local meetings, which are arranged entirely by local sections.

In this period were begun certain technical activities which have materially benefited industry and the general public. Boiler explosions are a rarity since the society undertook to prepare and continually revise a "boiler code," which has become law and the standard for 24 states, the Hawaiian Islands, Panama Canal Zone, two Canadian provinces and 18 cities, in the design, construction and operation of boilers and pressure vessels. As a further means of safeguarding human life, the society has sponsored other safety codes, such as those for elevators, already adopted in several states and a score of cities, hoists, compressed-air machinery, pressure piping and conveying equipment. To determine whether an engine or machine is delivering its rated horsepower or capacity, the society has set up for the guidance of engineers "power test codes" to be used in testing compressors, heaters, internal-combustion engines, fuels, pumps, steam engines and turbines, refrigerating systems, steam locomotives and other auxiliary apparatus.

At the beginning of the period, the society added research to the list of its technical activities. Unaffected by commercial considerations or influence and interested primarily in the advancement of knowledge of mechanical engineering, the society has sponsored research on fluid meters, feedwater studies, management, cutting of metals, mechanical springs, effect of temperature upon properties of metals, woods of the

world, gearing, bearings, hydraulics, steam tables, elevators, welding and lubrication. Another important function of the society is its service to the engineering profession and to industry in the sponsorship of dimensional standardization in the field of mechanical engineering, beginning with pipe threads and including bolts, nuts, rivets, screw threads, couplings and hundreds of other items. This last activity has made possible mass production in the automotive and other fields, which in turn have provided the general public with cheaper automobiles, household appliances, typewriters, airplanes and similar articles.

The pattern of the third period of the society's development, now in progress, appears to be characterized by a growing concern for the education and training of the engineer and his professional development and status, for engineering as one of the learned professions, and for the opportunities and obligations of public service, which involve economic and sociological as well as ethical, educational and financial considerations. The vital problems, personal, professional and national, raised by the world-wide depression of the 1930's, have already influenced and given direction to this third period, which is roughly coincident with the secretaryship, held since the death of Dr. Rice in 1934, by C. E Davies.

To enhance the status of the engineer, the American Society of Mechanical Engineers is maintaining its high technical and cultural standards for entrance to the society; cooperating with educational institutions in the maintenance of high standards of engineering education; requiring a high standard of ethical practice by members of the society; aiding in the adoption of a high standard of attainment for the granting of the legal right to practice professional engineering; fostering among engineering students the study of philosophy and history, tradition and achievements, duties and social functions of the engineering profession; encouraging the personal and professional development of young engineers; and supporting activities looking to the increased employment of engineers and seeking new opportunities for engineering service. The usefulness of the organized engineering profession is being increased by cooperating with other engineering and technical societies; encouraging a high standard of citizenship among engineers; encouraging engineers to participate in public affairs; cooperating with governmental agencies in engineering matters; and fostering a better understanding by the general public of the value of engineering as evidenced by the achievements of engineers.

L. F. Z.

SPECIAL ARTICLES

UNIFORMITY OF THE PAIN THRESHOLD IN MAN[1]

THE aim of these studies was to ascertain: To what extent the variable distress experienced by different persons during similar pain stimuli is dependent upon differences in perception (the pain threshold), and to what extent on differences in reaction to pain.

Earnest efforts in the past[2] have been made to deal with this problem, but a definite answer has been delayed because of the absence of an accurate method of ascertaining the pain threshold. A suitable method has been described by Hardy, Wolff and Goodell,[3] who have made accurate measurements of the pain threshold and have demonstrated its stability in three subjects. The day-to-day variations over a period of almost a year, despite varying moods and vicissitudes, caused a deviation from the mean no greater than ± 12 per cent. However, the pain threshold may be altered by various factors. Thus, pain in one part of the body raises the pain threshold in other parts. Also, chemical agents such as acetylsalicylic acid and the opiates are capable of appreciably raising the pain threshold, on which fact rests part of their therapeutic usefulness.[4]

To investigate the variability of the pain threshold in a population under average conditions of well-being, 150 subjects of different ages and both sexes were tested. The results of this more comprehensive study of the pain threshold form the topic of this communication.

METHOD

The apparatus[3] for measuring the pain threshold is shown diagrammatically in Fig. 1. The light from a 1,000-watt lamp was focussed by a condensing lens through a fixed aperture 1.8 cm. in diameter onto the blackened forehead of the subject for exactly three seconds. The intensity of the radiation was controlled by means of a rheostat. The subject reported on his sensation, and if no pain was experienced the procedure was repeated every 30 to 60 seconds until he just felt pain at the end of the exposure. The intensity of heat at this point was measured by a radiometer and considered to be the minimum stimulus for pain. This

[1] From the Russell Sage Institute of Pathology in affiliation with the New York Hospital and the Departments of Medicine and Psychiatry, Cornell University Medical College, New York, N. Y.

[2] E. Libman, *Jour. Am. Med. Asn.*, 102: 335, February 3, 1934.

[3] J. D. Hardy, H. G. Wolff and H. Goodell, *Jour. Clin. Invest.*, 19: 649, July, 1940.

[4] H. G. Wolff, J. D. Hardy and H. Goodell, *Jour. Clin. Invest.*, 19: 659, July, 1940.

threshold pain was easily recognized, even by untrained subjects. The sensation was that of heat finally "rising" or "swelling" to a distinct sharp stab of pain at the end of the three-second exposure.

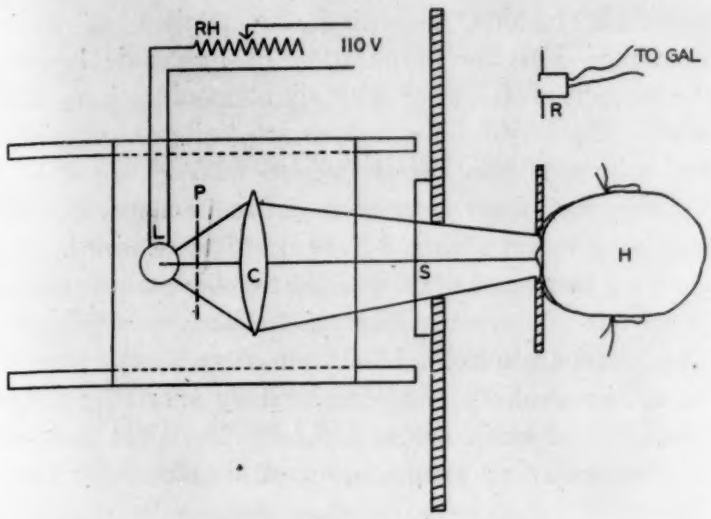

FIG. 1.

RESULTS

Observations were made on 150 subjects. A few subjects were repeatedly examined at intervals of several days and weeks. There were 324 observations on 150 subjects. The data were considered on the basis of a single value for each subject, which was the average of all observations made on the subject. These individuals were of both sexes, of various ages and of widely different social and educational experience. They were individuals who at the time of examination had no pain, infection or gross metabolic disturbance. Each subject was asked to express an opinion about his own pain sensitivity. The average amount of energy necessary to produce just the beginning of pain at the end of the three-second exposure, that is, the pain threshold, was 0.206 gm.cals/sec./cm². The range of threshold readings was from 0.173 gm.cals./sec./cm.² to 0.232 gm.cals./sec./cm². The distribution of results is shown in Fig. 2. The average of these data in absolute value is 10 per cent. lower than the average obtained by Hardy, Wolff and Goodell on three carefully studied subjects. The measurement of energy in this intensity range in absolute value is a difficult technical procedure and the agreement of the observations made with an entirely different apparatus may be considered adequate. The series of pain-threshold determinations when plotted produced a bell-shaped curve with −16 to +13 per cent. as the limit of deviation from the mean, and with 91 per cent. of all determinations falling within ± 8 per cent. The standard deviation for the group was ± 1 per cent.

There were wide variations in the expression of personal estimates of pain perception, such as "exquisitely sensitive to painful stimuli," "average" and "very insensitive to pain." With few exceptions, however, there was no relation between the personal estimation of hypersensitivity or hyposensitivity and the pain threshold as measured here.

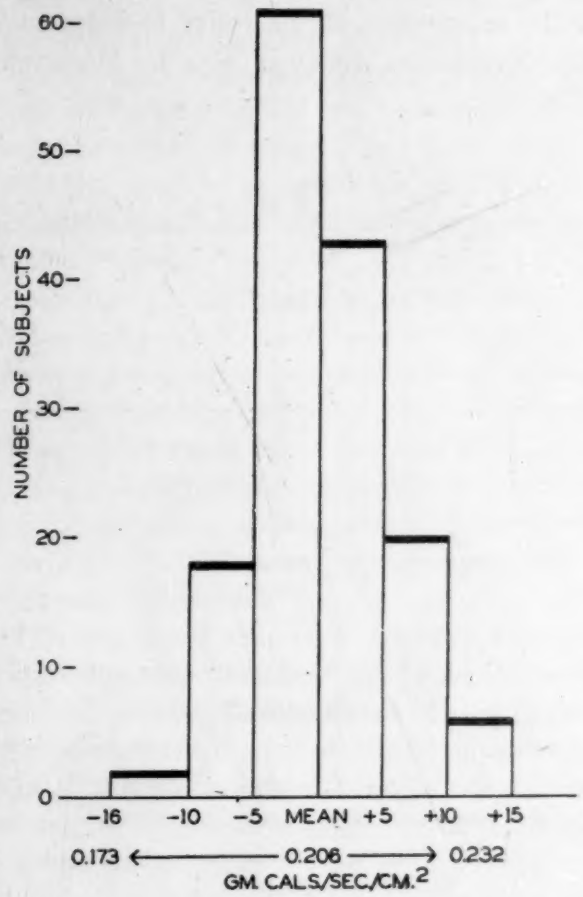

FIG. 2.

To test further whether or not sleep loss would affect the stability of the pain threshold, hourly and sometimes half-hourly observations were made upon four subjects (authors) over a span of 24 hours. A total of 103 observations (each consisting of 2 independent measurements) was made. During this time the subjects carried out, in so far as possible, their usual daily activities, including eating. Sleep, however, was completely avoided. All drugs, including coffee and tobacco, were omitted except three hours before the experimental period ended. At this time three of the subjects took a cup of coffee each, whereas one took no coffee.

Throughout the 24 hours each of the subjects experienced wide variations in both the degree of wakefulness and in emotional state. The former ranged from alertness and effectiveness to weariness, drowsiness and lethargy. The emotional states ranged from good humor, calmness and placidity, elation and gayety, to indifference, apathy, dullness, restlessness, irritability and tension.

The 150 pain threshold values again varied but slightly from the mean threshold value as determined for the four subjects throughout the 24-hour period. This mean value was 0.210 gm.cals./sec./cm.², the range being from 0.193 gm.cals./sec./cm.² to 0.227

gm.cals./sec./cm². The limits of deviation from the mean were ± 8 per cent., and 95 per cent. of all the determinations fell within ± 5 per cent. of the mean. No difference was noted between those who, toward the end of the experiment, drank coffee and the one who did not. Results are shown in Fig. 3. Macht,[5] using

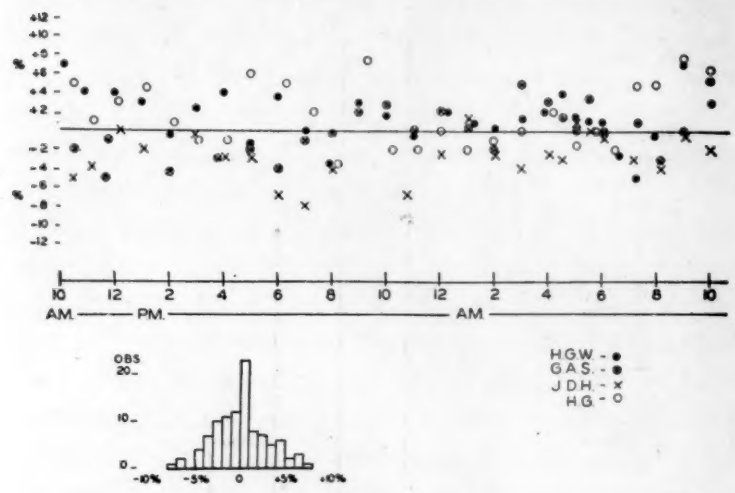

FIG. 3.

another method, obtained similar constant values for the pain threshold throughout 26 hours.

From these data it is inferred that the pain threshold in man is relatively stable and uniform. In contrast to this uniformity in the threshold for the perception of pain are the wide individual variations which occur in the reaction to pain. This latter seems to be dependent upon individual experience and attitude.

CONCLUSIONS

(1) Pain threshold in 150 persons of different ages and of both sexes was approximately the same, 0.206 ± 0.03 gm.cals./sec./cm². The standard deviaiton for the group was ± 1 per cent., the same as previously observed for individual subjects.

(2) Pain threshold could not be correlated with the subject's estimates of his or her sensitiveness to pain.

(3) Pain threshold was independent of sex.

(4) Pain threshold is uniform throughout the 24-hour day and not affected by feelings of lethargy, tension and over-irritability, nor lack of sleep for a 24-hour period.

(5) Individual reactions to pain are not the result of individual variations in pain threshold.

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THE UTILIZATION OF L-GLUCOSE BY MAMMALIAN TISSUES AND BACTERIA

EMIL FISCHER observed in 1890 that l-glucose was not fermented by brewer's yeast.[1] Since no further work has been reported on the ability of other cells to metabolize this sugar, mammalian tissues and bacteria were examined in this respect.

The l-glucose was prepared by the reduction of l-gluconic lactone, following the method of Emil Fischer.[1] For the preparation of l-gluconic lactone the method of Kiliani,[2] with slight modifications, was used. The crystalline anhydrous l-glucose obtained had a specific rotation of $(\alpha)_D = -52.5°$.[3]

Experiments were carried out manometrically on surviving tissue slices of the rat. The respiration of the gray matter of brain and the aerobic and anaerobic glycolysis of Sarcoma 39 were measured according to Otto Warburg's method.[4] It was found that l-glucose is neither oxidized nor fermented by surviving tissue slices of rat brain or Sarcoma 39; nor does it affect the oxidation or fermentation of d-glucose by these tissues.

L-glucose is not metabolized in the animal body, as shown by the following experiment: A rat was injected intravenously with a 5 per cent. solution of l-glucose equivalent to 1 gram of l-glucose per kilogram of body weight. The amount of l-glucose excreted in the urine was determined polarimetrically. Approximately 85 per cent. of the l-glucose was excreted within twenty-four hours.

B. coli communis (Escherichia) and *Bacterium aerogenes* were cultured in a synthetic salt medium to which was added 1 per cent. d-glucose and 1 per cent. l-glucose, respectively. Both bacteria grew on d-glucose, but neither showed any appreciable signs of growth on l-glucose.

In another experiment the synthetic salt medium was replaced by Dunham's peptone solution. Bromothymol blue was added to indicate changes in pH, and inverted small tubes (Durham tubes) were used for collecting gas. The two test cultures (*B. coli* and *B. aerogenes*) grew well in the control tubes containing d-glucose, but no growth was observed in the tubes containing l-glucose. Acid and gas were formed in twenty-four hours by both bacteria in the presence of dextrose, but no acid or gas by either in the presence of l-glucose.

SUMMARY

The utilization of l-glucose by rat tissues and *B. coli* and *B. aerogenes* was studied. There was no evidence that l-glucose was metabolized by either mammalian or bacterial cells.

[5] D. I. Macht, N. B. Herman and C. S. Levy, *Jour. Pharmacol.*, 8: 1, 1916.

[1] E. Fischer, *Berichte*, 23: 2611, 1890.

[2] Kiliani, *Berichte*, 55: 100, 1922; 58: 2349, 1925.

[3] The l-glucose was prepared by Edith L. Anderson, working under a grant from the Banting Research Foundation.

[4] O. Warburg, "The Metabolism of Tumours," Constable and Company, London. 1930.

The author wishes to express his gratitude to Dr. E. Anderson for the preparation of the l-glucose and to Professor W. L. Holman, of the department of bacteriology of this university, for carrying out the bacterial tests.

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TULAREMIA ENDOTOXIN

I OBTAINED a strong tularemia endotoxin from Hamzabey and Ceylon strains which I had isolated from a brook during the investigations[1] of the tularemia epidemic in Thrace in 1937.

These strains were cultivated in plates containing blood and cystin media. These cultures were then emulsified in sterile distilled water, placed in flasks containing beads. These flasks were then put in tin boxes lined with cotton and incubated in 37° C. incubators for autolysis. The boxes were shaken thoroughly twice daily. The incubation lasted 45 days, during which time all the tularemia bacteria died. After the product was found completely sterile it was centrifugalized. The clear, sterile autolysite was then desiccated in vacuum in the presence of sulfuric acid. The dry endotoxin thus obtained was dissolved in sterile distilled water, having 50 mg of dry toxin in 1 cc. It was recentrifugalized. The tests made with the broth-colored solution gave the following results:

(1) White mice weighing 20 grams, injected intravenously with 0.3 cc of this solution (15 millig. of dry toxin) = (M. L. D.), died instantly with severe convulsions.

(2) The intraperitoneal injections of the same amount killed the mice within 24 hours.

(3) Guinea-pigs weighing 250–300 grams were injected 15 centigrams of dry toxin intraperitoneally, and they died within 24 hours with typical cries.

(4) The intracutaneous injections of 10–15 millig. of dry endotoxin caused a passing vasoconstriction at the site of injection.

(5) Repeated intravenous injections to rabbits showed the antigenic value of the endotoxin by the presence of a marked flocculation reaction. Moreover, it was found that the endotoxin produced titratable flocculation and precipitation reactions with the sera of persons who had previously had tularemia infection, as well as with those of guinea-pigs with chronic tularemia infection. These sera also neutralized the cutaneous vasoconstriction.

(6) The endotoxin does not contain hemolysins.

Finding it possible that this endotoxin can be used as a standard toxin in the standardization and control of tularemia antisera, and that the detoxicated toxin can be used for the prevention of the disease, I thought the publication of this work might be of some use to other workers in this field.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE THROMBOPLASTIN REAGENT FOR THE DETERMINATION OF PROTHROMBIN

FOR the satisfactory quantitative determination of prothrombin by my method,[1] a thromboplastin is required which is stable and has a high and uniform activity. Such an agent can readily be prepared as follows: a rabbit brain, from which the superficial blood vessels have been removed by stripping off the pia, is mascerated in a glass mortar under acetone. After several replacements of fresh acetone, a granular non-adhesive product is obtained which is dried on a small suction filter. The dehydrating process should not require more than 10 minutes and the acetone must not be acid (Eastman's Practical is satisfactory). As soon as the thromboplastin is free of acetone, it is put in a glass ampule which is evacuated by means of an oil vacuum pump for 3 minutes and then sealed in a gas flame. For convenience 0.3 gm material is put in each ampule. To prepare the emulsion, this amount of dry material is mixed with 5 cc of a freshly prepared 0.85 per cent. sodium chloride solution, incubated for 15 minutes at 50° C., and then allowed to stand until the coarse material is settled and a milky supernatant liquid is obtained. The presence of suspended material does not interfere with the test. Centrifugation often reduces the activity of the emulsion. The thromboplastin solution prepared in this manner will, according to the technique of my test, clot human plasma in 11 to 12½ seconds and rabbit plasma in 6 seconds. For research purposes no preparation which does not bring about coagulation in these periods should be employed.

Curiously, the dehydration of rabbit brain with acetone or with dioxan markedly increases the thromboplastic activity. There is at present no explanation for this finding. Whereas an emulsion of fresh rabbit brain clots human plasma in 16 to 25 seconds, the thromboplastin made by the acetone method brings about clotting in 11 to 12½ seconds. Dehydration with acetone, moreover, makes the product much more constant in potency. It seems, therefore, advisable to

[1] *Zentr. f. Bak.* (*Referate*) *B.C.* xxix, No. 5–6, 1938; *Népegészségugy*, No. 21, 1938.

[1] A. J. Quick, M. Stanley-Brown and F. W. Bancroft, *Am. Jour. Med. Sci.*, 190: 501, 1935; A. J. Quick, *Jour. Am. Med. Assn.*, 110: 1658, 1938; 111: 1775, 1938.

abandon the use of fresh brain, even though Souter, Kark and Taylor[2] have recently described a satisfactory way for preserving thromboplastin extract by means of the lyophile procedure of Flosdorf and Mudd.

Thromboplastic activity is destroyed by oxidation. If dried rabbit brain be allowed to remain in contact with air, it slowly turns yellow and a concomitant loss of potency occurs. By storing the reagent in an evacuated tube, oxidation is prevented and the activity is retained apparently indefinitely. As an example, a preparation made on March 3, 1938, was tested on June 6, 1939, and found it clotted human plasma in 11½ seconds. The unused portion of the sample was resealed under vacuum and tested on June 24, 1940. Again clotting occurred in 11½ seconds.

Thromboplastin possesses a relative but not an absolute species specificity. Rabbit thromboplastin appears to be specific for the plasma of man, dog, cat, horse and cow, but not for the plasma of the guinea pig or for birds. It is interesting to note that repeated search has failed to find any better source for thromboplastin than rabbit brain.

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A STOPCOCK LUBRICANT FOR USE WITH SOLVENTS, ACIDS OR ALKALIES

DURING the past few years the writer has done considerable work with solvents such as carbon disulfide, petroleum ether, acetone and other similar solvents in separatory funnels and burettes.

Many different compounds have been used as stopcock lubricants. Some of these are good for certain solutions but unsatisfactory for others.

About two years ago while searching for a satisfactory stopcock lubricant for use with carbon disulfide the writer tried some powdered graphite which was on the shelf in the laboratory. It has proved to be a valuable substance for use as a lubricant where the ordinary compounds are dissolved away.

Graphite is insoluble in all ordinary solvents and is not affected by acids or alkalies. It does not allow the stopcock to bind and it gives a very satisfactory seal. Only a very small amount should be used. A stopcock once coated usually lasts a long time.

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SHADOWGRAPH RECORDING OF AVENA COLEOPTILE CURVATURES

GROWING oats in battery jars, in place of specialized seed holders, for the Went coleoptile assay method for auxin, seems to have a number of distinct advantages. When this technique is employed, shadowgraph records may be conveniently taken with the aid of an easily constructed device described below and figured in the accompanying drawing.

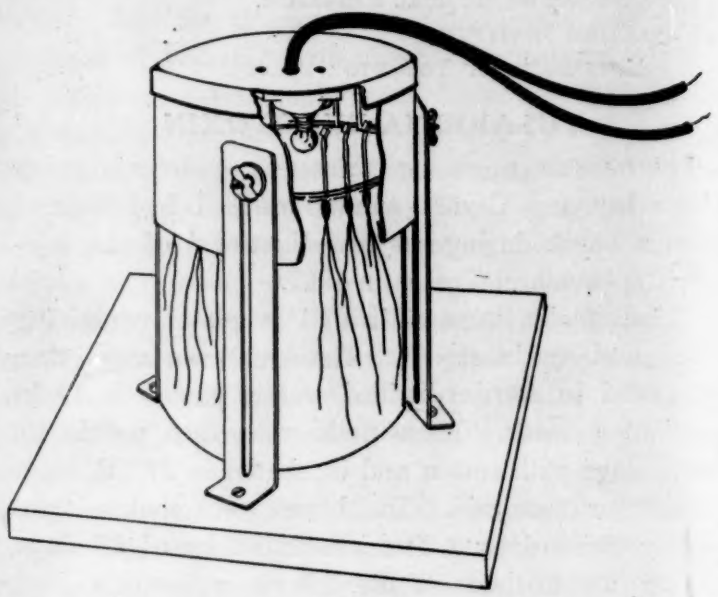

FIG. 1.

A copper cylinder 4″ in diameter and 3″ in height is made movable up and down along slots in three copper legs attached securely to a base board. The cylinder may be held in any position by means of winged nuts that tighten against the legs on screws attached to the cylinder. The lower rim of the cylinder is curled up on the inside to support a strip of photographic paper. Covering the cylinder is a copper lid, in the center of which is placed a small single filament flashlight bulb operating on two dry cells.

We have used this set-up with battery jars 3⅞″ in diameter and 5″ in height in which 20 to 25 oats are able to grow uniformly. Satisfactory results have been obtained with both single and double exposures of the reacting coleoptiles.

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